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ABSTRACT

Differences in levels of subject matter learning at the university level were explored to determine how a learning task is approached between those who are successful and those who are less successful. Students read a selected social science text, (Paul Samuelson's "Economics", for example), related the material learned, answered content questions, gave personal impressions of the learning activity, and discussed general attitudes toward university studies. A second interview, five to six weeks later, concentrated on retention of previously learned material. Two major attitudes appeared to be connected with two different conceptions of learning--one that learning is something a person does and the other that learning is something that happens to a person. These attitudes determined to a large extent the things students learned, as well as the different ways in which they learned. These findings indicated that learning should be described in terms of the structural aspect of its content. In the section exploring the relationship between knowledge and skill, it is shown through experimentation with physics phenomena in a problem-solving situation that cognitive skills are aspects of knowledge, rather than independent of knowledge. Remarks on the debate on education during the 1970s and on separate categories of thought are offered. References and a listing of reports from the Institute of Education, University of Goteborg, Sweden, are provided. (Author/DB)

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INVESTIGATIONS INTO THE LEARNING AND TEACHING OF BASIC CONCEPTS IN ECONOMICS (2)

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SKILL AS AN ASPECT OF KNOWLEDGE

Some implications from research on students conceptions of central phenomena in their subjects

Paper presented at the Second International Conference on Improving University Teaching, July 13 - 16, 1976, Heidelberg, F.R. Germany.

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No 55 September 1976 2

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Learning: process and outcome[1]

"What makes some people better at learning things than others?" If you ask this question you will probably get the answer that it has to do with intelligence (some people are cleverer, more gifted, better equipped). Those who answer in this way seem to be satisfied with this 'explanation' and if you ask them, after a while, what it means to be intelligent (clever, gifted, intellectually well-eqipped etc). they might very well answer that it means that one is good at learning things.

Dissatisfaction with this type of 'explanation' - which is unfortunately not so rare in the field of behavioral science, - was the starting point of a project concerning higher education, which our research group initiated in the beginning of the 70's.[2]

We were quite simply interested in what difference there is in how a learning task is approached between those who are successful and those who are less successful. Do they tackle the task in different ways and if so how can these different ways be described ?

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1) This report has been made with financial support from the R and D Unit of the Office of the Chancellor of Swedish Universities. I owe a debt of gratitude to my collegue Lennart Svensson for the basic idea on which this report is based. For a more detailed and correct treatment of this idea the interested reader is referred to his work "Study Skill and Learning" (Svensson, 1976).

2) The project, which was carried out during the years 1970-74, had the same title as Lennart Svensson's above-mentioned work (i.e. Study Skill and Learning). After its conclusion, the project was followed by several others of which one concerns higher education. It deals with the learning of economics at university level and is mentioned briefly below (cf. also Dahlgren and Marton, 1976).

The question would, of course, be quite impossible if it concerned learning in general (i.e. all types of learning). Our starting point was the interest in a certain type of learning, namely, the learning which can be said to be the most typical for the 'students' learning' at the University's faculty of social sciences. What is typical in this case, according to our point of view is that one is supposed, by means of either a written or an oral account, to arrive at an understanding of the phenomena treated by this account. In accordance with this we carried out a series of experiments where the learning material consisted of texts which were either taken from the course literature of some academic subject (pedagogics, political science, economics) or was considered to be of such a nature (concerning both from and contents) that they might have been included in the course literature. The texts were rather extensive (1.400 - 24.000 words) compared to what could be considered normal in learning experiments.[3]

All the experiments were performed individually and verbally. This means that each subject came alone to the experimenter. The experimenter told her what to do and after that she read the text that had been chosen to represent the learning material. After reading the text, the subject had to relate what she had learnt from the text, answer questions on the contents and give her impressions of her own learning activity while reading and retelling the text. The interview was then concluded with a discussion of questions about what the subject thought of studying at the university and how she managed her study work. Each such investigation was followed, after 5 - 6 weeks, by a new interview where among other things, we concentrated on a qualitative description of the retention of the reading and questioning.

Asking people to give their observation of inner processes, i.e. learning, is called introspective method. This procedure was frequently used in the early phase of psychology at the end of the 19th century and at the beginning of the 20th century. Since interest has been more and more concentrated on what

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3) Apart from the works mentioned in the text there are several other reports on these studies (e.g. Dahlgren, 1975; Marton, 1976; Marton and Säljö, 1976).

is observable to others (and not only to oneself), i.e. on behaviour, the introspective method lost much of its reputation. During the 60's, however, questions once more started to be asked about what happens "inside man" from the point of view of psychology. In that way the introspective method regained the position as one out of several possible procedures in educational and psychological research.

Every method of course restricts what may result from the investigation; how a phenomenon is observed decides to a certain extent what we may arrive at concerning this phenomenon. Our subjects described their experiences of the learning process to a great extent in terms of the orientation of their attention. When analyzing what the subjects had related we decided on a contrasting relationship which was used to characterize how the subjects reacted towards the learning task. On the one hand, there were those subjects who orientated themselves towards making out what the aim of the text was. They assumed that the text was about something and they tried to make out what it was. On the other hand, there were those who concentrated on the text itself. They simply tried to remember the wording.

These differences appeared consistently in various learning experiments. They were found also during the interviews concerning the study situtation at the university. The students who took part in our investigations differed as to whether they defined the content of their academic subject in terms of aspects of the surrounding world which were dealt with or in terms of the books which constituted the course literature. In the first case, they seemed to experience knowledge as a part of themselves or as a change in their way of conceptualizing certain phenomena in the world around them. In the latter case, on the other hand, knowledge was experienced as something external, something that existed independent of the personality.

These two attitudes appeared to be connected with two different conceptions of learning: learning as being something you do and learning as being something that happens to you.

What happens when people read a text in these two different ways? It is fairly natural to think that people with different ways of learning learn different amounts. It also did appear that the subjects who belonged to the first of the above-mentioned groups learned consistently more than the others. But what is far more important is that people with different ways of learning learned, to a great extent, different things.

In an experiment (Säljö, 1975) 40 students read a text taken from the Swedish edition of "The World Educational Crisis" (Coombs,1971). Among other things, the author argues in this text against the conventional way of looking at "the output of education" as the number of students who pass their examination. The real output of education, according to the author, is the effect on the individual and society of the education through the knowledge and attitudes which the individual acquires during his education. Consequently, we ought include those who interrupt their studies without passing the examination. To look at knowledge and attitudes as "the output of education" is an abstract thought which most people find difficult to understand. When the experimenter, after reading the text, asked what the author meant by "the output of education" more than half of the students who took part in the experiment answered that "the output of education" is the number of examination passes, i.e. the statement which the author argues against, was given as the answere. Apart from those who had understood the point, there were some who had understood that even those who leave the education system without an examination must be accounted for. Another group of subjects gave a vague answer synonymous to output: "That which comes out of the education system".

Forty answers which were all different as regards linguistic form could be grouped in four qualitatively different ways of conceptualizing the topical idea:

What is the output of education?

A Knowledge and attitudes (acquired through education)

B Those who leave the educational system (with or without an examination)

C Those who pass their examinations.

D What comes out of the educational system.

Students, then, may differ, not only with regard to how much they learn, but also to what they learn. Learning, in our opinion, must be described in terms of the latter. If a certain teaching method, for instance, leads to better results in learning than another, this will certainly mean that the students to a certain extent learn different things in both cases. It is important to realize that knowledge is very seldom homogenous; it is not so that some people have correct and identical answers, while others have no answers at all. In fact, most students have some idea of the point in a text they have read even if this idea may be more or less wrong or diffuse. If a teacher wants to counteract false conceptions in his teaching he ought to know what these conceptions are.

In our experiments we found throughout a strong correlation between the subjects' orientation during the process of learning and the understanding they reached. On the whole, those who were orientated towards finding a message in the text did so, while those who were orientated more towards the words did tend to get fixed on the level of the words. What you are orientated towards during the reading of a text and the understanding you reach of this text can be seen as two aspects of the same thing. The outcome of learning, which we describe in qualitative terms, contains in itself to a certain extent the process which has lead to the outcome; from what a person has learnt we may conclude how he has learnt it.

Learning should be described in terms of the structural aspects of its content

Our view is, that, instead of studying learning and teaching in such, i.e. how learning takes place in general and what factors (external in relation to the contents) facilitate learning, research should be directed towards studying what is learned in relation to various concrete contents and towards investigating what conceptual prerequisites the understanding of these contents demands. Such information would, in all likelihood, be an important contribution made by pedagogical research to pedagogical practice.

Notice that we do not argue for an endless listing of conceptions of the one subject content after the other, nor do we argue for a total disintegration of

The question is, what ideas and principles we choose to study the understanding of and at what level we wish to describe the differences in conception. Our starting-point is that certain ideas and principles are more fundamental than others since the understanding of them constitutes the prerequisite of conceptions of other ideas and principles. The understanding of Pavlovian conditioning implies, for instance, the understanding of the concept of stimulus. The understanding of the political system as a feed-back loop implies, of course, the understanding of the idea of feed-back and the understanding of the idea of "significant at the 5 % level" in statistics implies the understanding of the idea of sampling distribution.

In accordance with this point of view we have, of course, chosen to study the understanding of the ideas which we find the most fundamental. It should be noted, however, that in the above-mentioned examples it is at least theoretically possible to study the stimulus concept by means of studying Pavlovian conditioning, to study the concept of feed-back using the political system as a starting-point or to study the concept "sampling distribution" in connection with the concept of "level of significance". These so-called fundamental concepts are always present and even if we are not aware of them they come to the fore in connection with the study of the less fundamental concepts. Another way of expressing this is that we do not regard a "deeper" and a less deep concept as two different units having a certain relationship; rather we see them as aspects of a certain phenomenon that differ as regards depth.

In one of the studies (Marton and Dahlgren, 1976), the learning material used consisted of two chapters from the Swedish edition of Paul Samuelson's book "Economics" (Samuelson, 1969).[4] In this study, the authors' main interest was concentrated on how the subjects understood the two main principles in chapter 2, namely, the production possibility frontier and the law of diminishing returns. The production possibility frontier illustrates "... the menu of choice along which... society can choose to substitute guns for butter" (ibid. p 22). It depicts the fact that "... in order to get equal extra amounts of one goods society must sacrifice increasing amounts of other goods" (op. cit. p 29). The

4) The citations given below are, however, taken from a later English

law of diminishing returns "... refers to the diminishing amount of extra output that we get when we successively add equal extra units of a varying input to a fixed amount of some other input" (op.cit. p 25).

The qualitative differences in the conception of these two principles were interpreted as being an expression of more fundamental differences between a static and a dynamic conception of allocation. In the former case one thinks in terms of a constant output of production that can be divided in different ways. In the latter case one reasons in terms of productive resources and not in terms of the output of production; it is not only the distribution of the output of production that can vary but also the latter's size due to differences and/or increases in the utilization of the resources. The actual allocation of these resources (e.g. between consumption and investment) can affect their future size.

Knowledge and skill

Whether answers to questions on different contents give evidence of a static or a dynamic conception of allocation is thus an expression of the structural qualities of knowledge and indisputably touches on the question of cognitive skills. Furthermore, it is obvious that if we apply sufficiently deep level aspects to knowledge we find structural characteristics which are also found in the content-matter of different subjects. This is one reason why research within educational psychology should not be pursued at a general and content-neutral level or divided solely according to different academic subjects and consistently concentrated on the specific contents of those subjects.

An important problem is that cognitive skills are often regarded as being over and above knowledge. In actual fact, cognitive skills would seem to have more to do with the nature of knowledge and how it is handled by the individual. Thus cognitive skills are not, in our opinion, independent of knowledge. On the contrary, we see skills as aspects of knowledge.

We shall try to show what we mean with the help of a fairly detailed discussion of a study made many years ago. Székely (1950) carried out an experiment the aim of which was to try to find the answer to the question "Does a functional connection exist between insightful previous learning and subsequent productive problem solving?" The learning conditions in this experiment were varied in order to find out whether it was possible to find differences in a later situation, in which problems had to be solved, that corresponded to the differences in learning conditions. The first method, which was called the modern method, began with a demonstration of a torsion-pendulum (see figure 1) which consisted of a bar suspended in a horizontal position on a thread. Four hooks were attached to the underneath surface of the bar. The pendulum was rotated a certain number of revolutions and the subjects were asked what they thought the effect would be if weights were hung on the two inner hooks or on the two outer ones. The majority answered "I don't know" or "It wouldn't make any difference since the weights are the same". A few thought that the speed of rotation would be higher when the weights hung from the two outer hooks because of the centrifugal force. The experimenter then showed the subjects that in actual fact the speed of rotation was considerably higher when the two weights hung from the inner hooks. The subjects were then told the following; "You were unable predict this effect, and even now cannot explain it, because you lack the necessary knowledge of physics. Please read these four pages. You will then be able to comprehend and explain the observed phenomenon". The text elaborated some elementary concepts of mechanics such as "work, output, propulsion, momentum of rotation, momentum of inertia and impulse of rotation". After having read through the text the majority of the subjects were able to give a satisfactory explanation of the observed phenomenon, i.e. by moving the weights to the outer hooks the momentum of inertia of the weight is increased and the speed of rotation is thus diminished.

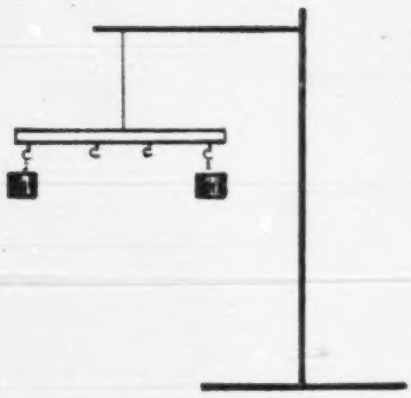

Figure 1
Torsion-pendulum (Székely, 1950)

Under the second condition, which was called the traditional method, the subjects were asked to read through the above-mentioned text. This was followed by the same demonstration with the torsion pendulum as was given to the previous group. This time, however, the demonstration illustrated the text and did not constitute a starting-point for a penetration of it. The correct explanation of the behaviour of the pendulum was given and both the demonstration and the explanation were then repeated once more.

The learning experiment was followed two to four days later by the problem-solving phase. In order not to make the connection between the two tasks obvious, the second part of the investigation started with a problem not connected with the experiment. This was followed by the problem with the two balls. The first question concerned the problem of how it was possible to have two metal balls of exactly the same size and weight but which consisted of different metals - one was heavier than the other. The subjects either realized that one of the balls had to be hollow or were helped by the experimenter to arrive at this conclusion. After this followed the real problem: "How can one decide which of the two balls is made of the heavier metal, assuming that they are identical to look at and that they may not be tampered with?"

The 40 subjects who participated in the experiment had previously taken part in a similar experiment in which it was determined whether their understanding of the problem used was of a general nature or if their thinking was based on the specific context within which the problem was presented. (This description of inter-individual differences in the learning process is thus not completely unlike our own description above, where similar differences are described in terms of concentration on the intentional content of the text or on the text itself). With regard to the experiment in question, care was taken to make sure that there was an equal number of subjects in the two groups (the traditional and the modern method) with a general and a specific orientation respectively.

The solution to the problem with the two balls is that if one starts them rolling, either by placing them on a sloping surface or by pushing them with the same amount of force, the hollow ball will rotate more slowly due to the fact that its momentum of inertia is greater. The number of subjects who arrived at this solution can be seen in table 1, in which both the variation between learning conditions (modern and traditional methods) and between individuals (general and specific orientations) are taken into consideration.

Table 1

Number of subjects who succeeded, or failed, in solving "the two-ball problem" (Székely, 1950)

Method	Solution	Orientation	
		general	specific
Modern	yes	8	5
	no	2	5
Traditional	yes	4	0
	no	6	10

As can be seen from table 1, the probability of solving the problem varies together with both learning conditions and individual qualities. Thirteen out of 20 subjects who were exposed to the "modern method" succeeded in arriving at the solution compared with 4 (out of 20) exposed to the other condition (the traditional method). On the other hand, there were 12 subjects with a general orientation who managed to solve the problem compared with 5 subjects with a specific orientation.

Not only the frequency of solutions but also the procedure for arriving at a solution was different in the two "teaching groups". The subjects who had been exposed to the "modern method" searched in the problem-solving situation for a difference between the two balls that could be directly observed and was related to whether the ball was hollow or solid. After a number of guesses such as "heat them" or "something to do with electricity" the fact that one could roll them suggested itself. On being asked why by the experimenter they answered that they had a decided feeling that the solution was related to the distribution of the mass, and that the more it was concentrated to the surface area the greater was the resistance towards motion. As a rule, they were not conscious of the connection between the learning task and the problem they were in the process of solving. Only 5 of the 13 successful subjects working under this condition noted this connection.

Of the subjects who were exposed to the "traditional method", the four who succeeded in solving the problem did not reason in the intuitive fashion mentioned above. They based their reasoning on the fact that it was possible in the new situation to apply what they had read earlier and in this way arrived at the solution.

After the problem-solving task, the subjects were asked to reproduce the definition of the momentum of inertia. Four subjects from the group using the "modern method" and eight subjects from the other group were able to do this. Of these 12, two were from those who were successful in solving the problem. The author's conclusion is that productive application and verbal reproduction of what has been learnt tend to be negatively related to each

other. This means that it can be an advantage if that which has been learnt is freed from the specific context and the specific formulation it had when first presented to the learner. The result of learning becomes usable in a general sense due to the fact that it sinks in, as it were, and becomes part of oneself.

It seems that two conditions need to be met if the problem is to be solved. Firstly, one must see the two balls from a fresh viewpoint, namely, in terms of differences in the distribution of the mass: "In the process of reasoning, the conception of the sphere was enriched by a new property". The other condition is, naturally, that one must then realize that the difference in the distribution of the mass signifies a difference in the momentum of inertia which in turn means a difference in the speed of rotation.

Why do we give such a detailed description of a study made by another researcher more than 25 years ago? We think that this experiment provides a clear demonstration of the title we have given this paper, namely, a demonstration of the principle that skill can be considered as an aspect of knowledge. It is not true that the difference in the process of solving a problem can be described by saying that the subjects who have acquired the same knowledge differ as regards their skill in applying it. On the contrary, in this case the subjects learnt different things when they were exposed to the material and the differences in the ability to solve the problem at a later time can, to a great extent, be attributed to what they learnt in this learning situation.

In the case treated above, the term skills refers to the ability to utilize a certain principle (the relation between the momentum of inertia and the speed of rotation). When we talk about skills we often think, quite obviously, about more general qualities. Skills which are aspects of knowledge can also be easily overlooked due to the very fact that they are present, as it were, everywhere. In a research project which concerns the comprehension of some basic concepts in Economics at university level, Dahlgren and

Marton (1976) noticed that many students tend not to think in terms of economic reality but rather in terms of the graphic representation chosen in order to describe that reality. Also in science education it is frequently found that the graphs, symbols and formulas chosen to represent properties of the physical reality are not apprehended by most of the students as something related to their everyday experience of this physical reality (i.e. to their experience of speed, acceleration, pressure etc).

These kinds of differences can be pointed out in each specific case. However, there is a risk that they will not be pointed out at all for the very reason that they are present in each specific case.

Some remarks concerning the recent debate on education

The debate on education during the 70's can to a certain extent be characterized as a reaction against the worst excesses of the wave of educational technology. According to the orthodox model of educational technology, the objectives of teaching should be specified as clearly and in as much detail as possible. The sequence of measures that constitutes the most efficient way of reaching these objectives should then be worked out. Thus, the starting-point is the content of the course and the instrument is different types of educational materials. In the present debate on education we see once more the equivalent (or rather the antithesis) of these two ideas. Firstly, it is argued that learning in school must be based on the learner's own situation, interests and needs. This can be seen as a watered-down version of Paulo Freire's basic ideas which are perhaps best known from the book "The Pedagogy of the Opressed" (Freire, 1970).

The second fundamental conception is that all of society (including the physical surroundings) can be regarded as an educational materials. This conception is found in perhaps its most consistent form in the works of another of the pedagogical debate's dominating figures, namely, Ivan Illich (primarily in his "Deschooling Society", 1970).

A pedagogical model that unites both these basic conceptions is the so-called project method. In the field of higher education, one of the most radical attempts to apply this method has been made at Roskilde University Centre in Denmark. The work takes place in groups containing an average of seven persons. At the beginning of term, each group chooses a problem (or problem area) that it wants to work on. Two tutors (teachers) are attached to each group. The teachers are part of the resources available to the group and are called in when it needs their help. Each project is expected to result in a report handed in at the end of the term. The report should contain - apart from a description of the procedures used and a statement of the results - comments on how the team-work functioned.

As far as we know, no evaluation has been made of the organization of studies at Roskilde at the time of writing. A previous member of our research group in Göteborg, Birgitta Fransson, summarizes her impressions of Roskilde and other, similar experiments in the following way: "There have ... often been difficulties in convincing receivers on the labour-market and within the educational system that this new type of education can be placed on an equal footing with traditional education as regards knowledge content... This hesitation has often resulted in the radicalism of the experimental work being moderated, an "adjustment towards the middle" has taken place since students, as in the case of society in general, cannot afford to allow education to be private matter, a self-realization's cul-de-sac. The outside world's expectations as regards education's formal content limits the work form and the organization of examinations." (Fransson, 1975)

Our impression is that the discussion is often carried on in terms of a contrast between knowledge and skills. On the one hand, it is claimed that knowledge is of secondary importance, what matters is to learn "how to learn". On the other hand, warning cries are raised in the face of the approaching danger of a drop in the standard of knowledge. There is a tendency in both quarters to regard knowledge and skills as two different things which means that one as to be favoured at the expense of the other.

Since cognitive skills, in our opinion, have to do with being able to penetrate into, and at a deep level understand, different contents, then such skills must consist of aspects of how certain different contents are treated. If the training of skills is only aimed at skills in the sense of technique (e.g. to use reference books, to underline, to find one's way around a library) then one has missed what we consider to be the real purpose of the cognitive skills. On the other hand, concentration on knowledge at a superficial level, i.e. more or less in the form of learning by rote, is unlikely to result in knowledge of any value or interest. One should seek to promote as deep an understanding of different contents as possible, independent of whether one insists upon skills or knowledge. If one has a certain content of a course or a curriculum as a starting-point, then wholehearted concentration on deeper understanding means that the content must be reduced drastically from a quantitative point of view compared with what is usual today. If, on the other hand, one starts with different concrete problems rooted in the students' own experiences and spheres of interest, then one must endeavour to take the analysis to a sufficiently deep level. Irrespective of the content one begins with, one must arrive at a set of a limited number of scientific concepts and principles in terms of which an unlimited number of varying phenomena can be interpreted. If this is not done and if one - as the learner - does not penetrate further in one's analysis of the initial problem than that which is idiosyncratic or specific for just that problem, then one is hardly better equipped to meet new problems.

Separate categories of thought do not necessarily refer to separate phenomena

The developmental psychologist Heinz Werner has, like other researchers, emphasized that cognitive development from childhood to adoulthood in western civilization is characterized by an increasingly abstract and strongly systematized conception of the world around one (Werner, 1957). This process of abstraction means that we perceive different aspects of the same phenomenon which we then regard as constituting separate categories of thought; these categories can then be treated one at a time, as it were.

In this paper, we have consistently argued against seeing these separate categories of thought as representing separate phenomena. General concepts, for example, often represent deeper aspects than specific concepts and not independent entities. In our opinion, the relation between skills and knowledge is the same.

The problem with abstraction is that we can often no longer see the phenomenon, which we have divided into different subaspects, as a whole.

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